

ADT PLM

Programmer's Learning Machine

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IJD Seminar, 2016-02-02

1 Presentation of PLM

- Purposes
- Demo
- About PLM
- Architecture

2 To a web app

- Goals
- Server-side
- Client-side

3 Assessment of user's code

- Challenges
- Extraction of the execution component
- Docker

4 Result

5 Next steps

Outline

1 Presentation of PLM

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Presentation of PLM

Purposes

- Application to learn programming.

Presentation of PLM

Purposes

- Application to learn programming.
- Allows students to progress at their own speed...

Presentation of PLM

Purposes

- Application to learn programming.
- Allows students to progress at their own speed...
- ... while the teacher helps the ones having trouble.

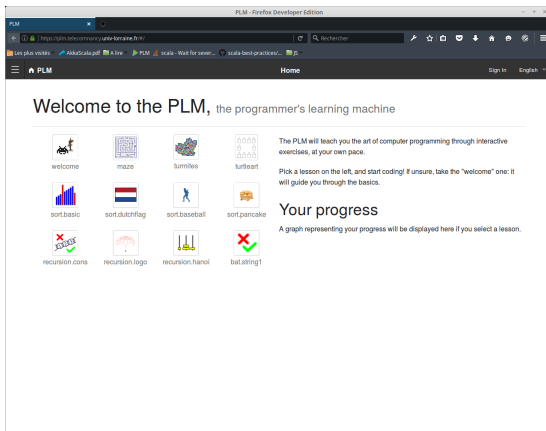
Presentation of PLM

Purposes

- Application to learn programming.
- Allows students to progress at their own speed...
- ... while the teacher helps the ones having trouble.
- Used at TELECOM Nancy since 2008.

Presentation of PLM

Quick demo



- Available at <https://plm.telecomnancy.univ-lorraine.fr>

Presentation of PLM

12 lessons, 200 exercises

PLM - Mozilla Firefox

https://plm.univ-lorraine.fr/la/lessons/maze/maze.wallFollowerWallFollowerMaze

Les plus visités Linux Mint Community Forums Blog News NinjaMock - free tool... Spotify Web Player Wau The Most Amaz... Coursa P2P

PLM Maze / WallFollowerMaze Se connecter Java Français

World Objective



Résultats de l'exécution

Éditeur de code:

```
public void run() {  
    // ...  
}
```

Cas de tests:

Another labyrinth Labyrinth

Presentation of PLM

12 lessons, 200 exercises

PLM - Mozilla Firefox

https://plm.univ-lorraine.fr/.../recursion/hanoi/hanoi.lessons/hanoi.Hanoi

Recherche

Les plus visités Linux Mint Community Forums Blog News NinjaMock - free tool... Spotify Web Player Wau The Most Amaz... Coursa P2P

PLM Recursion.hanoi / HanoiBoard Se connecter Java Français

World Objective

0 Move



Résultats de l'exécution

Cas de tests:

solve(0,1,2) solve(1,2,0) solve(2,0,1)

Éditeur de code: Réinitialiser API

```
public void hanoi(int height, int src, int ether, int dest) {  
    ...  
}
```

Presentation of PLM

12 lessons, 200 exercises

PLM - Mozilla Firefox

https://plm.univ-lorraine.fr/ta/lessons/recursion/logo/recursion/logo/tree.Tre

Les plus visités Linux Mint Community Forums Blog News NinjaMock - free tool... Spotify Web Player Wau The Most Amaz... Coursa P2P

PLM Recursion.Logo / Tree Se connecter Java Français

World Objective



Éditeur de code: Réinitialiser API

```
public void tree(int steps, double length, double angle, double shrink) {  
    // ...  
}
```

Résultats de l'exécution

Cas de tests:

tree(10,100,90,0.68)	▶	tree(10,80,45,0.7)	▶
tree(7,75,15,0.8)	▶	tree(7,75,30,0.8)	▶

Presentation of PLM

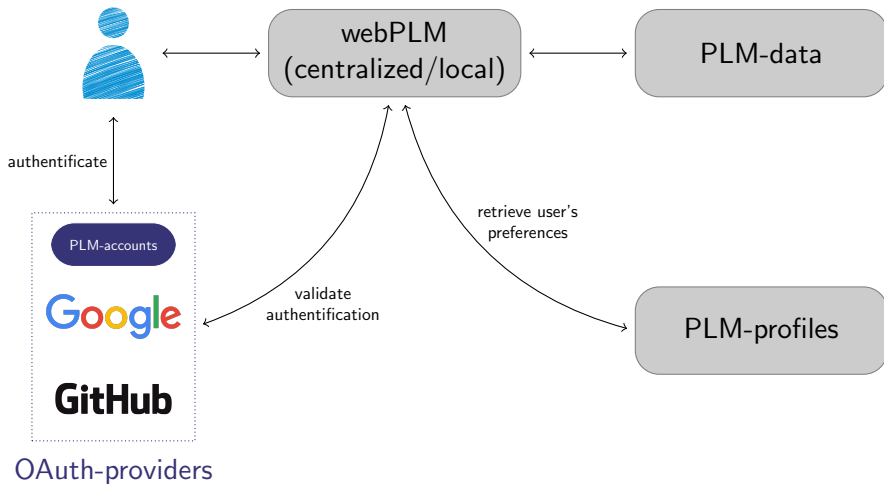
Languages and programming languages

- Available languages:
 - English
 - French
 - Brazilian Portuguese
- Supported programming languages:



Presentation of PLM

Application's architecture



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To a web app

Evolution of the project

- Formerly a fat client
 - Written in Java

To a web app

Evolution of the project

- Formerly a fat client
 - Written in Java
- Switch to a web application
 - Server implemented in Scala using *PlayFramework*
 - User interface written in Javascript using *AngularJS* and *Foundation*



To a web app

Motivations

- Want to switch to SaaS¹
 - Easy to use
 - Easy to update
 - Easy to track usage data
- More user-friendly
- Aim to setup SPOC² and MOOC³
- But don't have the time and means for a reboot

¹Software as a Service

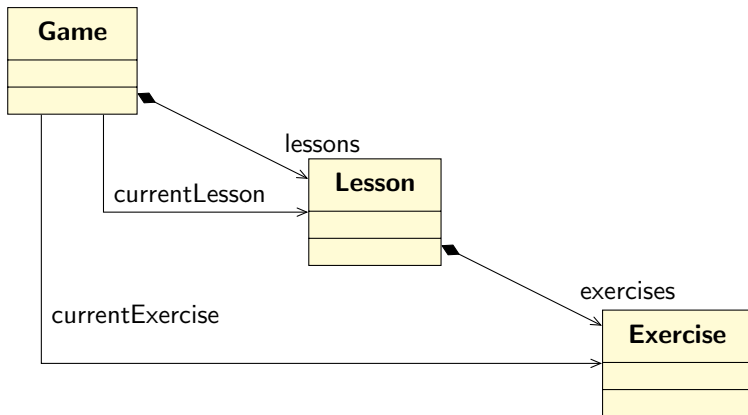
²Small Private Online Course

³Massive Open Online Course

To a web app

Refactoring PLM

- Implemented a headless version of PLM: *PLM-engine*
 - Provide all PLM's content and methods
 - But without a user interface



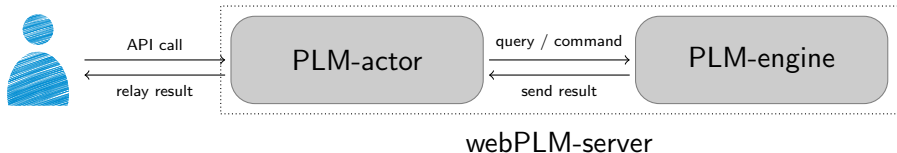
To a web app

Implementing the server

- Designed an API over PLM-engine
- Only need to implement a controller
 - Verify calls received from the client
 - Query or command PLM-engine according to the call
 - Send back result or acknowledgement to the client

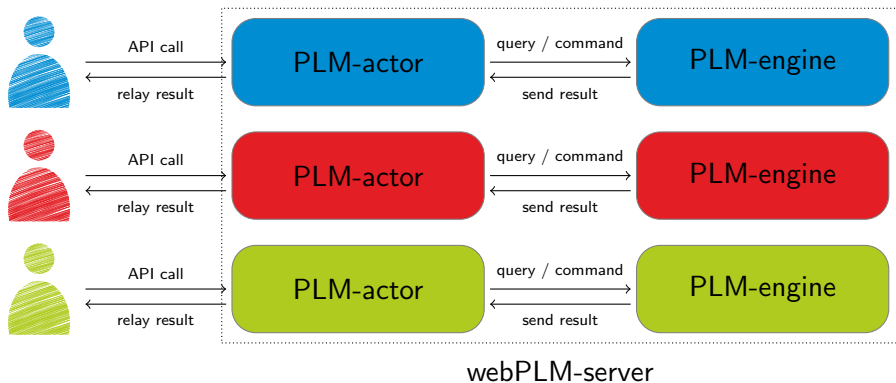
To a web app

Interactions between components



To a web app

Multi-user scenario

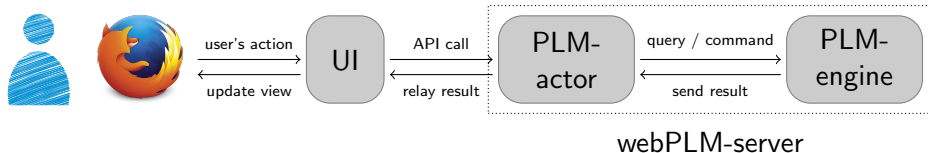


To a web app

Results

- Build quickly a web server from the fat client...
- ... but we also need a user interface

To a web app



To a web app

- Have to translate user's actions into API calls
- Have to re-implement PLM-engine's data models

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Assessment of user's code

Limits

- Run on the same machine, same JVM

Assessment of user's code

Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
 - Infinite loops

Assessment of user's code

Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
 - Infinite loops
- And from more malicious "mistakes"?
 - Infinite thread creation
 - Endless file creation

Assessment of user's code

Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
 - Infinite loops
- And from more malicious "mistakes"?
 - Infinite thread creation
 - Endless file creation
- And from *System.exit(whatever)*?

Assessment of user's code

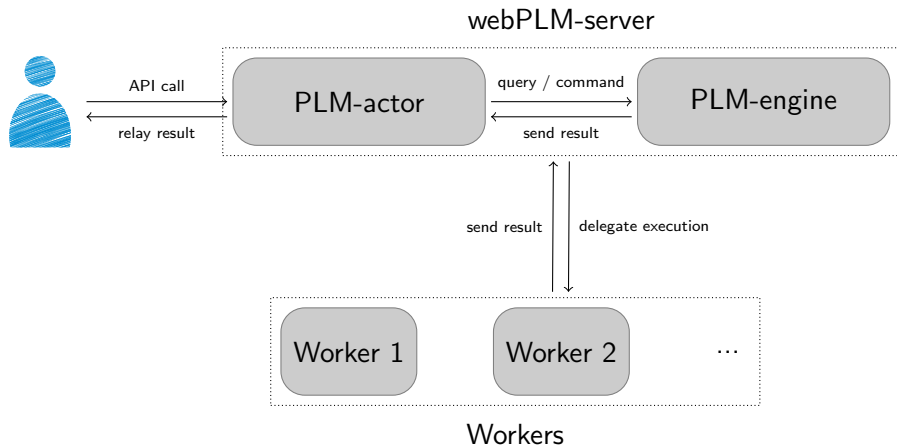
Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
 - Infinite loops
- And from more malicious "mistakes"?
 - Infinite thread creation
 - Endless file creation
- And from *System.exit(whatever)*?
- Scalability issues

Assessment of user's code

Chosen solution

- Delegate execution to workers



Assessment of user's code

The judges

- Called *Judges* in the litterature
- Use PLM-engine as well
- Workflow:
 - Retrieve an execution request
 - Parse the request to extract parameters
 - Configure PLM-engine according to them
 - Run the user's code
 - Send back result to webPLM

Assessment of user's code

Message queues

- Message-driven architecture
- Loosely coupled system
- Asynchronous/Synchronous
- Help to implement:
 - Producer/Consumer pattern
 - Request/Response pattern
- Different reliability patterns of the message processing:
 - Only one worker
 - At least one worker
 - All workers
- Easy to scale

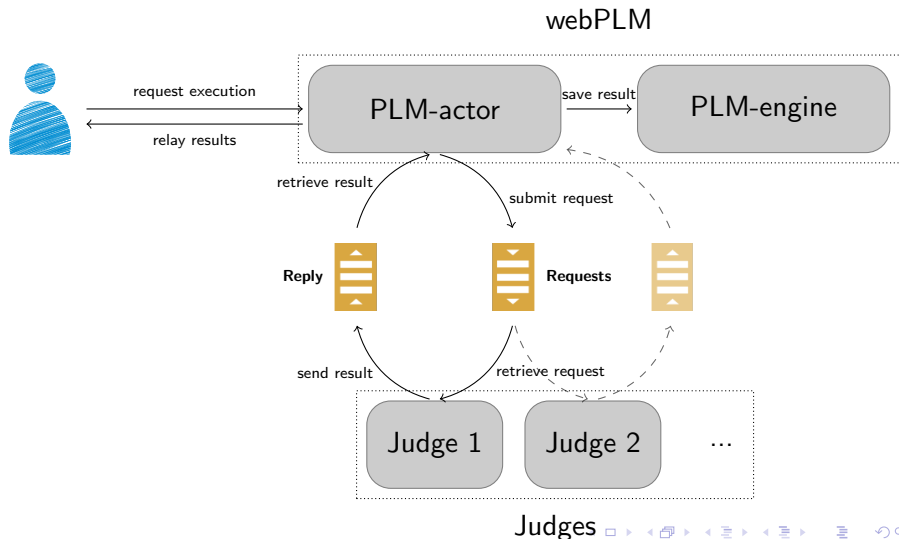
Assessment of user's code

Message queues

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- **Asynchronous**/Synchronous
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- Different reliability patterns of the message processing:
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Assessment of user's code

Architecture with judges



Assessment of user's code

Pros and cons

- Pros:
 - Allow to run code without impacting webPLM's performances
 - Meet the scalability requirements

Assessment of user's code

Pros and cons

- Pros:

- Allow to run code without impacting webPLM's performances
- Meet the scalability requirements

- Cons:

- Make sure to use the right version of PLM-engine
- Need to deploy them easily
- Should restart them after each execution
- Have to restrict their resources usage

Assessment of user's code

Docker

- Lightweight virtualization tool
- Build image of your application
- Run containers based on images



Assessment of user's code

Example of Dockerfile

- Dockerfiles describe how to set up the application

```
Dockerfile
1 FROM debian:jessie
2 MAINTAINER Gerald Oster <oster@loria.fr>
3
4 RUN apt-get update -y && apt-get upgrade -y && \
5     apt-get install --no-install-recommends -y -q apt-utils curl ca-certificates git unzip
6
7 RUN echo "deb http://ppa.launchpad.net/webupd8team/java/ubuntu trusty main" | tee /etc/apt/sources.list.d/webupd8team-java.list && \
8     echo "deb-src http://ppa.launchpad.net/webupd8team/java/ubuntu trusty main" | tee -a /etc/apt/sources.list.d/webupd8team-java.list && \
9     apt-key adv --keyserver keyserver.ubuntu.com --recv-keys EEA14886 && \
10    apt-get update -qq && \
11    echo debconf shared/accepted-oracle-license-v1-1 select true | debconf-set-selections && \
12    echo debconf shared/accepted-oracle-license-v1-1 seen true | debconf-set-selections && \
13    apt-get install -y --force-yes oracle-java8-installer oracle-java8-set-default && \
14    apt-get clean && rm -rf /var/lib/apt/lists/* /tmp/* /var/tmp/* /var/cache/*
15 ENV JAVA_HOME /usr/lib/jvm/java-8-oracle
16
17 RUN curl -O http://downloads.typesafe.com/scala/2.11.7/scala-2.11.7.tgz && \
18     tar xvfz scala-2.11.7.tgz -C / && \
19     rm scala-2.11.7.tgz
20 ENV SCALA_HOME /scala-2.11.7
21 ENV PATH $PATH:$SCALA_HOME/bin
22
23 RUN mkdir /app
24
25 WORKDIR /app
26 EXPOSE 9000 9443
27
28 ADD ["target/universal/stage", "/app/webplm-dist"]
29
30 WORKDIR /app/webplm-dist
31 CMD ["bin/web-plm", "-Dhttps.port=9443", "-men", "4096", "-J-server"]
32
```

- Run *docker build -t tag /path/to/Dockerfile* to build the image
- Start containers with *docker run tag*

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- Run *docker build -t tag /path/to/Dockerfile* to build the image
- Start containers with *docker run tag*

Assessment of user's code

More about *docker run*

- Can also manage
 - Ports

Assessment of user's code

More about *docker run*

- Can also manage
 - Ports
 - Volumes

Assessment of user's code

More about *docker run*

- Can also manage
 - Ports
 - Volumes
 - Links between containers

Assessment of user's code

More about *docker run*

- Can also manage
 - Ports
 - Volumes
 - Links between containers
 - Environment variables
 - Runtime constraints on resources
 - Restart policies
 - And a **lot more**

Assessment of user's code

More about *docker run*

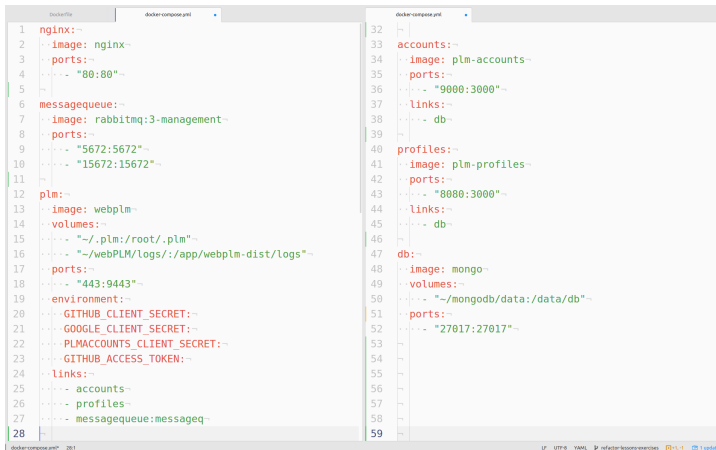
- Can also manage
 - Ports
 - Volumes
 - Links between containers
 - Environment variables
 - Runtime constraints on resources
 - Restart policies
 - And a **lot more**
- Commands can become quite complex

```
docker run -p 443:9443 -link plm-accounts:accounts -v  
~/webPLM/logs/:/app/webplm-dist/logs webPLM
```

Assessment of user's code

Docker-compose

- Tool to easily deploy multi-containers applications



```
1  nginx:~
2  ..image: nginx~
3  ..ports:~
4  ..- "80:80"~
5  ~
6  messagequeue:~
7  ..image: rabbitmq:3-management~
8  ..ports:~
9  ..- "5672:5672"~
10 ..- "15672:15672"~
11 ~
12 plm:~
13 ..image: webplm~
14 ..volumes:~
15 ..- "/.plm:/root/.plm"~
16 ..- "/webPLM/logs:/app/webplm-dist/logs"~
17 ..ports:~
18 ..- "443:9443"~
19 ..environment:~
20 ..- GITHUB_CLIENT_SECRET:~
21 ..- GOOGLE_CLIENT_SECRET:~
22 ..- PLMACCOUNTS_CLIENT_SECRET:~
23 ..- GITHUB_ACCESS_TOKEN:~
24 ..links:~
25 ..- accounts~
26 ..- profiles~
27 ..- messagequeue:messageq~
28 ~
32 accounts:~
33 ..image: plm-accounts~
34 ..ports:~
35 ..- "9000:3000"~
36 ..links:~
37 ..- db~
38 ~
39 ~
40 profiles:~
41 ..image: plm-profiles~
42 ..ports:~
43 ..- "8080:3000"~
44 ..links:~
45 ..- db~
46 ~
47 db:~
48 ..image: mongo~
49 ..volumes:~
50 ..- "/mongodb/data:/data/db"~
51 ..ports:~
52 ..- "27017:27017"~
53 ~
54 ~
55 ~
56 ~
57 ~
58 ~
59 ~
```

- Deploy environment with *docker-compose up*

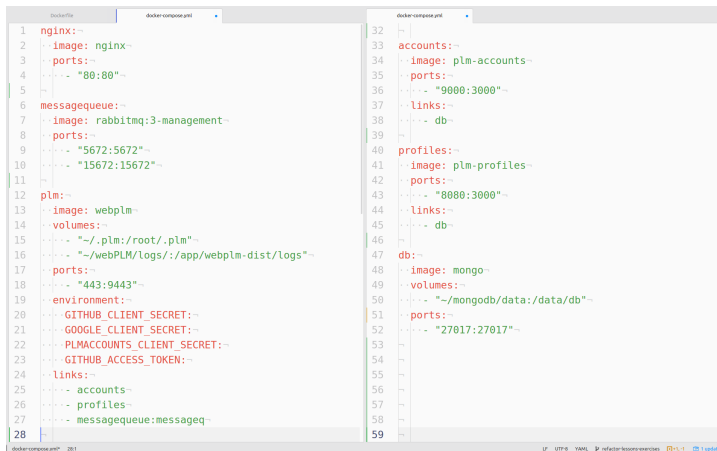
```
1  nginx:↵
2  ..image: nginx↵
3  ..ports:↵
4  .... - "80:80"↵
5  ↵
6  messagequeue:↵
7  ..image: rabbitmq:3-management↵
8  ..ports:↵
9  .... - "5672:5672"↵
10 .... - "15672:15672"↵
11 ↵
12 plm:↵
13 ..image: webplm↵
14 ..volumes:↵
15 .... - "~/plm:/root/.plm"↵
16 .... - "~/webPLM/logs/:/app/webplm-dist/logs"↵
17 ..ports:↵
18 .... - "443:9443"↵
19 ..environment:↵
20 .... GITHUB_CLIENT_SECRET:↵
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23 .... GITHUB_ACCESS_TOKEN:↵
24 ..links:↵
25 .... accounts↵
26 .... profiles↵
27 .... messagequeue:messageq↵
28 ↵
```

```
32 ↵
33 accounts:↵
34 ..image: plm-accounts↵
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38 .... db↵
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41 ..image: plm-profiles↵
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43 .... - "8080:3000"↵
44 ..links:↵
45 .... db↵
46 ↵
47 db:↵
48 ..image: mongo↵
49 ..volumes:↵
50 .... - "~/mongodb/data:/data/db"↵
51 ..ports:↵
52 .... - "27017:27017"↵
53 ↵
54 ↵
55 ↵
56 ↵
57 ↵
58 ↵
59 ↵
```


Assessment of user's code

Docker-compose

- Tool to easily deploy multi-containers applications



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- Deploy environment with *docker-compose up*

Assessment of user's code

Docker in our case

- Deploy easily all components
- Restart judges automatically
- Limit users' mischiefs

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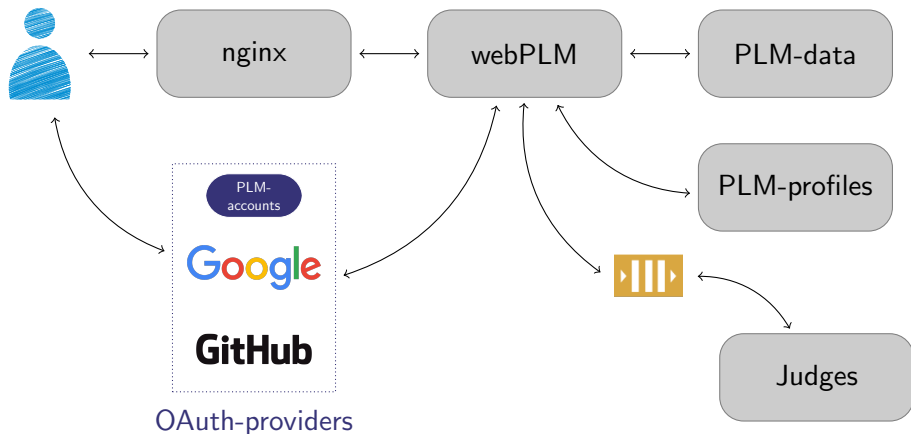
- Challenges
- Extraction of the execution component
- Docker

4 Result

5 Next steps

Result

Current architecture



Result

Live-session in TELECOM Nancy

- Rushed to release a stable version before the start of the school year
- Used in TELECOM Nancy in September 2015
- 30 hours of live testing with 100 students

Result

Live-session in TELECOM Nancy

- Rushed to release a stable version before the start of the school year
- Used in TELECOM Nancy in September 2015
- 30 hours of live testing with 100 students
- Engine is (almost) working fine...
- ... but user experience needs to be improved!

- Scalability issues:
 - Work well with small exercises
 - Can't cope with workload of larger exercises

Result

Live-session in TELECOM Nancy

- Scalability issues:
 - Work well with small exercises
 - Can't cope with workload of larger exercises
- No tools for monitoring set up...

Result

Live-session in TELECOM Nancy

- Scalability issues:
 - Work well with small exercises
 - Can't cope with workload of larger exercises
- No tools for monitoring set up...
- ... so the bottleneck is unknown.

Result

Refactor the code

- Needed to clean some parts of the code before further building
- Merged local and centralized mode branches

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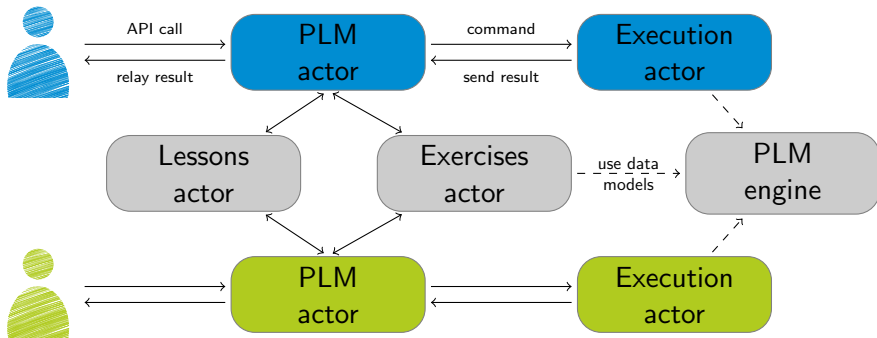
4 Result

5 Next steps

Next steps

Extract components from PLM-engine

- Most components are inside PLM-engine
- Updating PLM-engine → new version of webPLM and Judge
- Heavy and error prone workflow



- Allow to implement an exercise editor

Next steps

Solve performance issues

- Set up some monitoring tools
- Perform some load testing to identify the bottleneck

Next steps

Sneak peek from the TODO list

- Integrate interns' contributions
- Set up Continuous Deployment
- Support additional programming languages
- Implement a debug mode similar to popular IDEs' ones
- Add features to help teachers to supervise their students
- ...

Thanks for your attention, any questions?